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Title: Under-Deck Grid-Supported Drainage System

TITLE OF INVENTION

Under-Deck Grid-Supported Drainage System

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a Continuation In Part of Application Ser.# 10/190,956 which was Filed July 8, 2002, and Allowed November 17, 2003. The present Application claims benefit of Application Ser. # 10/190,956 which is a Continuation In Part of Application Ser. # 09/862,257 which was Filed May 22, 2001 and Allowed April 8, 2002. The present application claims benefit of the Allowed Application Ser. # 09/862,257 which is a Continuation In Part of Patent US 6,279,271 B1, issued August 28,2001. The present Application claims benefit of Patent US 6,279,271 B1 which claims benefit of Provisional Application Ser.# 60/110,164, Filed November 27, 1998. The present Application claims benefit of Provisional Application Ser. # 60/110,164.

Application Ser.# 09/862,257 also claims benefit of Provisional Application Ser.# 60/206,168 Filed May 22, 2000. The present application claims benefit of Provisional Application Ser.# 60/206,168.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable.

REFERENCE TO MICRROFICHE APPENDIX

Not Applicable.

BACKGROUND OF THE INVENTION

The present invention relates to a shedding and drainage system that can be installed, accessed and removed from underneath. More particularly, the present invention relates to a shedding and drainage system that can be installed under existing decks. A major application of the present invention is its installation under decks to help keep the area below dry and clean.

Typically, decks have planks for flooring with openings between the planks where water and other matter will infiltrate. Usually decks are attached to building structures. Many decks have useable space underneath, including lower decks and patios. It is often desirable to protect areas under decks from infiltration, particularly of rainwater, and divert the infiltration away from the area. Ways of dealing with infiltrations though decks include: building a flat or sloping roof at some level underneath the deck planks as part of the deck structure; attaching water shedding panels directly or indirectly to the deck joist; attaching water channeling troughs to the deck joists

A flat roof can be built below the planks and above the joists as part of the deck structure. This has to be done during deck construction. A sloping roof with framing can be built under the deck, much preferably previous to completion of deck construction.

Panels can be attached directly or indirectly to the bottom of deck joists. The author has witnessed plastic and plywood panels simply fastened to the bottom of deck joists A manufacturer of corrugated plastic panel suggests using shimming or sistering to obtain a slope. In the sistering procedure, sistering boards are attached to the sides of deck joists. In the shimming method boards varying in vertical height are attached to the bottom face of joists. Typically these boards are oriented parallel to the panel length and flow of infiltration. Then laths are attached transversely to then boards and the panels are attached to the laths. In any case, for support, the panels are attached to members transverse to their length, whether it be shims, sisters or laths. From the perspective below, the panels are connected to the sistering or shimming boards above though the concave portion of the corrugation. Most the flow then would be through convex positions of the corrugations.

Corrugated paneling is installed after the deck is constructed. A major problem with using shimming, sistering and similar methods is that debris tends to collect at the shimming boards, sistering boards, or laths, causing water pooling and leakage. Another problem is that it is difficult to get an adequate slope without using a large amount of wood. For example, to get a ½-inch slope per foot for a 12 foot length, sistering to deck joist, one would have to use nominal 10-inch wide lumber, if shimmering one may trim a nominal 2x8. Another problem with fastening panels from underneath is that they tend to look ugly and unfinished. Because of these shortcomings, the applicant has replaced and continues to replace installations by homeowners and handymen, including a shimmed system that was installed by a handyman just weeks before the applicant was asked to replace it.

Variations of trough (gutter) systems can be installed either during or after deck construction. Thibodeau 4,065,883 and Mickelsen 4,860,502 define a trough disposed between joists with flanges or lips that are fastened to the top of deck joists. A major limitation of theses inventions is that they

would have to be installed when the deck is being built. Also, the spacing between joists would have to be standard throughout for these to fit properly – a situation that is unusual. In addition, it would be very difficult to access the enclosed areas, without taking apart the deck, to do maintenance or solve leakage problems.

An embodiment of Mickelson 4,860,502 has troughs attached to joists sides that can be installed on existing decks. A major problem is that, although Mickelson can accommodate some variance in joists spacing, using the spring property of the trough, it is a pre-manufactured product and it would be very difficult to accommodate the largely irregular joist spacing of a great many existing decks.

Moore 5,511,351 and Moore 5,765,328 also has troughs attached to joists sides that can be installed on existing decks. This trough, made of a flexible material, extends under the deck joist. Ends of adjacent troughs overlap each other and are fastened to the joist at the overlapped portion. The overlapping and fastening occurs at the bottom joist surface for one embodiment-type, at the side of the joist for the other embodiment-type. Both types hide joists from view. Variations in distances between joists may be accommodated mechanically, but a satisfactory appearance of irregular troughs is questionable. A transverse gutter collects the drainage from the troughs and channels it to a drainpipe. A gutter on the opposite end of the troughs collects infiltration between the troughs and the adjacent structure. The flow then is channeled to one end of the trough effluents to the atmosphere. The inventor does not seem to have made provisions for the installation of chair swings, fans and the like through the troughs.

A major problem with all these trough-type drainage systems is that they are practically dependent on joist orientation and regularity of spacing between joists. Many decks are built with sections of joists going perpendicularly or diagonally to other sections. Some decks have sections at different levels. The mechanics and appearance of integrating irregular and/or transversely oriented troughs, perhaps at different elevations, is awkward at best and probably unworkable in a great many situations.

Another major problem is achieving satisfactory appearance. For appearance purposes, bottoms of decks with troughs in the joist area may preferably be covered, adding additional material and weight to the structure, and, making access for maintenance and leakage problems even more difficult. A series of aluminum or plastic troughs, hanging below the joist does not seem to blend in with the deck environment. Covenant organizations have concerns about a single gutter and drainpipe at a deck; how much resistance (probably justified) would they have about dozen aluminum gutters (troughs), hanging below deck joists, flowing into other gutters.

With the exception of Moore, handling infiltrations between the trough and the structure is another problem that generally is not addressed by the previous inventions. Presumably, at least for existing decks, a lot of caulking and flashing would be required in the joist space. If there is a maintenance problem with these, access could be very difficult. Moore takes care of this infiltration problem with another problem, with a gutter that channels the infiltration to one end of the gutter where it drips. Supposedly, this is in preference to the expense and appearance of an additional downspout.

OBJECTS AND ADVANTAGES

Accordingly, several objects and advantages of the present invention are:

(a) to provide an apparatus that protects areas under decks from infiltration of precipitation and debris, and the ensuing lingering moisture and wet deleterious conditions, thereby, protecting property and making space below decks more useable and comfortable;

(b) to provide a apparatus having a relatively simple geometric configuration, consistent repetition of patterns, and materials that pleasantly blend with deck features, whereby the installation of the apparatus esthetically enhances appearances under a deck;

(c) to provide an apparatus having an unobtrusive, blended and pleasant appearance, particularly from public view, which enhances the ability to obtain permission for use in communities under strict design covenants;

(d) to provide an apparatus that has a finished appearance in and of itself, such that it does not need to be covered with building materials, which add weight, expense and limit accessibility;

(e) to provide a system not dependant on joist configuration, which enhances appearance and versatility of workable configurations, including combinations of rectangular, circular, triangular and cascading areas;

(f) to provide system that is complete in that it that effectively intercepts, collects and channels infiltration to ground level and directs it away from the protected area;

(g) to provide an apparatus that has a substantially planar and unobstructed shedding surface with a sufficient slope, which allows debris to be washed and/or blown away, whereby the system properly functions requiring little or no maintenance;

(h) to provide a system with a holding means, whereby most members easily can be easily lifted, unsnapped or otherwise temporarily displaced from positions without requiring tools, thereby allowing easy access and maintenance;

(i) to provide a modular system with standard parts which enhances pre-manufacturing of stock items, custom fabrication of other items, kitting, and installation;

(j) to provide a system where the majority of members usually typically are slid or snapped into place, such that the apparatus proficiently can be installed from underneath existing decks;

(k) to provide a system with parts held together by bolt and screw fastening means and snap/gravitational holding means, useful in situations when a deck is rebuilt or the installation of the implementation is moved from one deck to another;

(l) to provide a system that is relatively light in weight, comprising non-structural members, and is removable -- thereby avoiding requirements for building permits;

(m) to provide a relatively inexpensive kit, whereby the apparatus can be installed by contractors, handymen and homeowners;

BRIEF SUMMARY OF THE INVENTION

A rather complete embodiment of the invention can be briefly described as panels over a wooden grid, with a gutter and downspout. The invention includes ledgers for primary support, which are attached to an adjacent structure, such as the underside of a deck and adjacent house. The wooden grid can be adjusted during installation to accommodate the irregularities of the adjacent structure. Generally, grid and panel members are set and scooted into position and can be lifted and scooted out of position for access.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

Fig. 1 is a profile of the invention.

Fig.2 and Fig.3 are details of the low-ledger assembly fitting into the joist-bracket of an endboard.

Fig. 4 shows how a grid section is disposed.

Figs. 5-8 show a cross-member to sloping-member connection, the cross-member having a bracket with an open-ended slot. Fig. 5 shows members unconnected and viewed from above. Fig. 6 shows members connected and viewed from above. Fig. 7 shows members unconnected and viewed from the side. Fig. 8 shows members connected and viewed from the side.

Figs. 9-12 show a cross-member to sloping-member connection, the cross-member having a bracket with a hole. Fig. 9 shows members unconnected and viewed from above, Fig. 10 shows members connected and viewed from above. Fig. 11 shows members unconnected and viewed from the side. Fig. 12 shows members connected and viewed from the side.

Figs. 13-16 show a cross-member to sloping-member connection, the cross-member having a bracket with a peg. Fig. 13 shows members unconnected and viewed from above, Fig. 14 shows members connected and viewed from above. Fig. 15 shows members unconnected and viewed from the side. Fig. 16 shows members connected and viewed from the side.

Figs. 17-20 show a cross-member to sloping-member connection, the cross-member having a solid bracket. Fig. 17 shows members unconnected and viewed from above, Fig. 18 shows members connected and viewed from above. Fig. 19 shows members unconnected and viewed from the side. Fig. 20 shows members connected and viewed from the side.

Figs. 21 and 22 show a cross-member to sloping-member connection, the cross-member having a middle-portion and end-portion of the same thickness. Fig. 21 shows members unconnected and v

Figs. 23-24 show a cross-member to sloping-member connection, the cross-member having a small projection, the sloping-member having a continuous slot. Fig. 23 shows members connected and viewed from above. Fig. 24 shows members connected and viewed from the side.

Figs. 25-26 show a cross-member to sloping-member connection, the cross-member having a small projection, the sloping-member having a series of holes. Fig. 25 shows members connected and viewed from above. Fig. 26 shows members connected and viewed from the side.

Figs. 27 and 28 show details of a spacer. Fig. 27 shows a spacer, face view. Fig. 28 shows a spacer, side view.

Figs. 29-31 show low-side configurations. Fig. 29 shows a low-side configuration with endboard; gutter behind beam. Fig. 30 shows a low-side configuration with a fascia board; gutter behind fascia board. Fig. 31 shows a low-side configuration hybrid; gutter hidden behind beam and fascia board.

Figs. 32-35 show high-side configurations. Fig. 32 shows a high-side configuration with a simple ledger. Fig. 33 shows a high-side configuration with a high-ledger, or high-ledger assembly, under a deck-header. Fig. 34 shows a high-side configuration using offset brackets. Fig. 35 shows a high-side configuration with a high-ledger, or high ledger assembly, disposed on the face of a deck-header.

Figs. 36-38 show overlapping panels disposed over a rafter. Fig. 36 shows corrugated panels. Figs 37 and 38 show panels having single corrugations at their edges, having a sine wave profile and a triangular profile, respectively.

Fig. 39 shows a profile view of panels and clip disposition.

Fig. 40 shows a plan view of panels and clip disposition.

Fig. 41 shows a side view of side-flashing and trim at an end-rafter.

Figs. 42 and 43 show a wind strap, top view and side view, respectively.

Figs. 44, 45 and 46 show a panel holding means with a nail and overlapping panels, viewed from the font, from above, and from the side, respectively.

Figs. 47–49 show a mid-ledger. Fig. 47 shows the disposition of a mid-ledger with a mid-level endboard. Fig. 48 shows a mid-ledger as viewed from the front. Fig. 49 shows details of a mid-ledger fitted into a mid-level endboard hanger.

Figs. 50–54 relate to mid-span supports. Figs. 50 and 51 show a wood post bracket from the side view and from the front view, respectively. Fig. 52 shows dispositions of mid-span hangers at a mid-ledger and at a low-ledger. Fig. 53 shows a mid-span hanger from the end-view. Fig. 54 shows a mid-span hanger with blocking attached to deck joists.

Fig. 55 shows an alternate to the attachment of the panel clip on a rafter in situation where the member of the low-ledger having an upstanding face is thin.

Figs. 56-59 show a cross-member to sloping-member connection, the cross-member having a horizontally projecting end-portion, the sloping-member having a hollow. Fig. 56 shows members unconnected and viewed from above. Fig. 57 shows members connected and viewed from above.

Fig. 58 shows members unconnected and viewed from the side. Fig. 59 shows members connected and viewed from the side.

Figs. 60-63 show a cross-member to sloping-member connection, adjacent cross-members sharing end portions having a hollow that straddles a sloping-member, the sloping-member having two vertical projections. Fig. 60 shows members unconnected and viewed from above. Fig. 61 shows members connected and viewed from above. Fig. 62 shows members unconnected and viewed from the side. Fig. 63 shows members connected and viewed from the side.

Reference Numerals in Drawings

1.....high-ledger
1a.....2x2 component of high-ledger
1b.....5/4 board component of high-ledger
1a1....upper-face high-ledger
1b1....upstanding-face of high-ledger
2.....low-ledger
2a.....2x2 component of low-ledger
2b.....5/4 board component of low-ledger
2a1....upper-face of low-ledger
2 b1...upstanding-face of low-ledger
2c.....filler low-ledger
3.....sloping-member
3a.....2x2 component of sloping-member
3b1....raised staple, as projection from upper-face of sloping-member
3b2....partially driven nail, as projection from upper-face of sloping-member
3b3....partially driven nails, which project from upper-face of sloping-member for solid bracket connection
3b4....depression in upper-face of sloping-member
4.....cross-member
4a.....cross-member slat
4b.....cross-member bracket
4b1....open-ended slot, or hollow, of cross-member bracket
4b2....hole, or hollow, of cross-member bracket
4b3....solid cross-member bracket
4b4....small projection of cross-member bracket
5.....spacer

5a.....spacer slat
5b.....spacer filler
5c.....spacer screw
6.....endboard
6a.....endboard plate
6b.....endboard hanger
7.....fascia board
8.....panel clips
8b.....drip edge of clip
9.....high-ledger flashing
10.....panels
11.....trim
12.....gutter
13.....deck joist
14.....adjacent beam
15.....deck post
16.....deck header
17.....nail and hole panel holding means
17a.....oversized hole
17b.....nail
18.....mid-level endboard
19.....mid-ledger
19a.....2x2 component of mid-ledger
19b.....5/4 board component of mid-ledger
19c.....notch
20.....wood post bracket
20a.....wood plate
20b.....side bracket
20c.....bottom bracket
21.....mid-span hanger
21a.....long screw or bolt
21b.....ledger bracket
21c.....double board blocking
21d.....blocking fastener
22.....offset bracket assembly
23.....side-flashing
24.....wind strap

24a.....wind strap strip
24b.....wind strap screw

DETAILED DESCRIPTION OF THE INVENTION

Component Materials

A preferred embodiment of the invention as presented herein generally is described using commercially available materials and using parts that can be manufactured/fabricated from commercially available materials. A practitioner could fabricate specialty parts or use alternate materials, or alternate methods of manufacture. Although pressure treated lumber is a source material described in the following, it generally may be substituted with cedar, redwood, oak, mahogany and other woods, plastics, metals etc.

Components can be made as follows. Some basic parts can be pre-manufactured and stocked. Nominal 2x2s, hereinafter called 2x2s, can be pre-manufactured by ripping 2x4s in half. The resulting stock item has an actual cross-sectional dimension of about 1.5-inches by 1 11/16-inches with a smooth straight cut surface on one side. Nominal 1x2s, hereinafter called 1x2s can be pre-manufactured by ripping 2x2 fence pickets in half. These have actual dimensions of about 1.5-inches by 9/16-inches with a smooth straight cut surface on one side. Nominal 5/4 x6 deck boards, hereinafter called 5/4 boards, have actual dimensions of about 1-inch x 5.5-inches. All wood members of the present embodiment are pressure treated. The 2x4s, from which the 2x2s are cut, are dried-after-treatment for increased stability.

Layout--Fig. 1

Fig. 1 illustrates a profile of the invention attached to a deck structure. The invention has a high-side and a low-side, so named, even though in some implementations the invention could be level. In practice under decks, the high-side usually is located at the house-side of the deck and the low-side is to the opposite side of the deck. The invention is primarily supported at the high-side by a high-ledger **1** and at the low-side by a low-ledger **2**. When attached to a deck, the high-ledger is usually attached to a deck header, deck beam, or house structure; the low-ledger is usually attached to deck posts, a deck beam, or indirectly to deck joists. In this embodiment the high-ledger is fastened to a deck header **16** at the high-side, the low-ledger is held by endboards **6**, which in turn are fastened to the deck at the low-side.

High-Ledger—Figs. 1and 32

The high-ledger **1** comprises a 2x2 **1a** fastened to the side of a 5/4 board **1b**, the 2x2 extends the full length of the 5/4 board. The cut side of the 2x2 faces upward, representing an upper-face, and is about 2.75 -inches below the top of the 5/4 board, the 2.75-inches of 5/4 board representing an upstanding-face adjacent to the upper-face. The high-ledger can be fastened to the deck header **16** with deck screws and brackets.

Low-Ledger—Figs. 1,2,3

The low–ledger **2** comprises a 2x2 **2a** fastened to the side of a 5/4 board **2b**. The 2x2 extends the full length of the 5/4 board less about 2-inches at both ends. The cut side of the 2x2 faces upward, representing an upper-face, and is about 1.5-inches below the top of the 5/4 board, the 1.5-inches of the 5/4 board representing an upstanding-face adjacent to the upper-face.

Figs 1,2&3 illustrate a means of supporting the low-ledger at its ends. An endboard **6** is disposed at both ends of the low-ledger. Each endboard comprises 2 sheets of ¾-inch B/C plywood fastened together with screws and/or nails, the higher quality faces exposed, to make a 1.5-inch thick plate **6a** with a face dimensions of about 10-inches wide by 16-inches long, the width extending horizontally, the length extending vertically. Nominal 6-inch joist hangers **6b** are disposed on a face of each endboard, about 1/8-inch above the bottom edge of the plate. Each endboard is fastened to a deck joist **13** and the adjacent beam **14**.

Fillers **2c**, comprising plates of ½-inch plywood, with about a 5-inch by 2-inch face area dimension, are fastened to the side of the 5/4 board, one on each end and on the same side as the 2x2. The outside edges of the plates are roughly flush with the 5/4 board at its ends and at its lower edge. The ends of the low-side assembly fit snugly into the joist hanger of endboards, one of which is disposed at each end of the low-ledger.

Sloping-Members—Figs.1 and 4

A plurality of sloping-members, or rafters, **3** each having two ends, are comprised of 2x2s **3a**, with the cut sides of the 2x2s facing upwards, representing an upper-face, and staples **3b** partially driven into the cut side. The staples have a 1-inch crown and project about 1/8-inch above the face of the 2x2. The staples, or stubs, are centered across the face of the 2x2 such that each leg is about ¼-inch from the sloping-member's edge. Starting at the end of each sloping-member, staples are disposed

uniformly, about every 2 to 3-feet. The staples represent small projections above the upper-face. The sloping-members rest one end on the high-ledger the other end on the low-ledger. The sloping-members are disposed perpendicularly to the low-ledger and generally uniformly about 24-inches on-center from each other generally about the full extent of the low-ledger. The 1 11/16-inch dimension of the sloping members normal to the upper-face, represent sides of the sloping members.

Fig. 4 is a plan view illustrating relationships among the sloping-members and lateral members. Lateral members in this embodiment comprise spacers **5** and cross-members **4**.

Cross-Members having Open-Ended Slots in Brackets--Figs. 4-6

A cross-member **4** of the present embodiment comprises a 22.5-inch slat **4a** with 2 brackets **4b**. The brackets can be made from 1/8-inch thick PVC with a face dimension of about 0.75-inch by 2-inches. The 1/8-inch thickness of the brackets represents a diminutive thickness. Each bracket has an upper-face and an under-side. Each bracket has on its face a slot, or a hollow, **4b1** about 1/8-inch wide, 0.25-inches long and open ended to one of its 0.75-inch edges. The brackets are fastened to the cut face of the slats, one bracket at each end of the slat with the slotted end facing longitudinally away from the slat, the bracket projecting approximately 5/8-inch beyond the end of the slat. Stapling is a convenient means for fastening the bracket to the slat. Regular sized cross-members, using 22.5-inch slats, can be manufactured and stored as stock items. The approximate 5/8-inch projections of the plastic brackets beyond the ends of each slat represent end-portions of each cross-member.

Smaller sized cross-members can be easily made-up in the field by taking a slat pre-fabricated with a bracket on one end, cut the slat to fit, then attach at the other end a bracket with screws.

Cross-Member Sloping-Member Interface—Figs. 4-8

The cross-members **4** are disposed perpendicularly to the sloping-members **3**, the cut side of the slats facing upwards, the brackets **4b** of the cross-members resting on the sloping members, the projecting staples **3b1** of the sloping-members project through the hollows **4b1** of the brackets, holding the cross-members in place.

The upper-face and sides of the sloping-members together with the small projections there from represent an interface with the end-portions of the cross-members. For the situation shown in Fig.4, where the hollow is an open ended-slot and the end-portion is of diminutive thickness compared to

the middle portion, the side of the sloping-member interfaces with the end of the slat of the cross-member.

Spacers--Figs. 4, 27 and 28

Spacers **5** comprise 1x2 slats **5a** about 22.5-inches long, two 0.5-inch thick wood fillers **5b**, and deck screws **5c** projecting through the slats, the fillers and into the vertical face, or upstanding-face, of the high-ledger. The slats are oriented with the 1.5-inch dimension vertical and the 0.75-inch dimension horizontal. Fillers can be approximately square in configuration, about 1.75-inches across and 0.5-inches thick. The upper edge of each filler should be level with the upper edge of the slat; the bottom edge of each filler is about 0.25-inches below the bottom edge of each slat. Spacers can be pre-manufactured by placing the two fillers and the slat into a template, basically to keep the top edges even, pre-drilling a hole slightly smaller than the screws, then inserting the screws. At installation spacers are set such that the bottom edges of the fillers rest on the ledger, then spacers are fastened to the vertical face of the high-ledger. Regular sized spacers can be pre-manufactured and stocked.

Grid--Fig. 4

The cross-members in combination with the sloping-members, the spacers, and the upper-edge of the low-ledger (when present) form a grid with a substantially planer upper-surface. The disposition of the spacers on the upstanding-face of the high-ledger, in effect, makes slots into which the sloping-members are fitted. The cross-members together with the spacers laterally restrain the sloping-members. The vertical face, or upstanding-face, of the low-ledger and the vertical face, or upstanding-face, of the high-ledger restrain longitudinal movement of the sloping-members. Fastening the sloping-members at the extreme ends of the ledgers, for example by coming up through the 2x2s with screws, finishes containing the complete grid. When using cross-members with brackets having open-ended slots, it is necessary to secure the end-rafters, or rafters at the extreme end of the grid.

Panels—Figs. 1, 4, 36-38

A plurality of corrugated plastic panels **10** rest on the upper-surface of the planer grid. Each panel has a nominal width of 2-feet and an actual width of about 26-inches. The panels are oriented so the rise and the fall of their corrugation is parallel to the low-ledger. The adjacent panels overlap each other about 2-inches, and are thus held to each other due to the corrugation. The panels generally overlap each other over the sloping-member as is illustrated in Fig. 36. The panels extend approximately from the face of the 5/4 board of the high-ledger to about 2-inches beyond the 5/4 board at the low-

ledger. Figs 37 and 38 show configurations of overlapping panels having single corrugations at their edges The panels generally are held into place by clips **8** at the low-ledger and by the projecting flashing **9** at the high-ledger. The clips and the projecting flashing represent a panel holding means in the proximity of the low-ledger and the high-ledger, respectively.

Panel Holding Means—Figs. 1, 32-35, 39, 40, 55

As is shown in Figs. 39 and 40, the panel clips **8** can be made from about 1-inch by about 4-inch strips of galvanized sheet metal. Each strip is bent along its long dimension ½-inch from one of its ends 90-degrees up, and bent at 1-inch from the same end 90-degress up to produce a j-configuration, with a slot ½-inch deep and ½-inch wide. The clips are fastened by nail or screw to the upper-edge of the low-ledger's 5/4 board generally one clip for each sloping members, in line with the rafters, projecting horizontally about 2-inches beyond the upper-edge corner of the 5/4 board away from the sloping member. Tightening clips is typically done by reaching over the fascia-board, or beam, or over an adjacent panel, and pulling the lip tight against the top of the overlapping panels.

An improved design of a panel clip **8** is shown in Fig. 39. This clip has a drip edge **8b** bent in its formation, to prevent water from traveling along the clip towards the low-ledger underneath the panel. The typical deposition of a clip in relation to a sloping-member is illustrated in Fig.40. Alternately, if the upper-edge of the low-ledger is small, the clips may be attached to the upper-surface of the sloping-members at the low-end of the sloping members, as is shown in Fig. 55.

The flashing **9** at the high-ledger is L-shaped, with the short leg about 1.75-inches long and the other leg about 2-inches long. The flashing is disposed with the short leg fastened to the face of the 5/4 board with the bend of the L-shaped flashing at about the same elevation as the upper edge of the 5/4 board, the long leg projecting over the spacer with a slightly downward slope. Generally the flashing extends the full length of the high-ledger. The flashing profile can be varied to adapt to various conditions of the deck header as is illustrated in Figs. 32-35.

A length of 1x2 trim **11** is disposed longitudinally with and projecting above the sloping-member at the extreme ends of the assembly can help hide from view edges of panels and flashing.

Gutter and Downspout—Figs. 29-31

Having an aluminum gutter **12** with a flat side, the flat side is fastened, by screw, nail, or staple, to the outside face of the 5/4 board of the low-side fascia **7**, about one screw per foot length of gutter. The flat side has a vertical dimension of about 3.5-inches. The screws are disposed about 1-inch from the

top edge of the gutter's flat side. The gutter has a high-end and a low-end. The elevation of the gutter drops usually at least 1-inch in 20-feet from the high end to the low end. The upper-edge of the flat side at the gutter's high-end is at about the same elevation as the upper edge of the low-ledger's 5/4 board. The upper-edge of the flat side at the gutter's low end is up to a maximum of about 2-inches below the upper-edge of the flat side at the gutter's high end. A downspout protrudes from the gutter near its low end, usually at a post of the deck.

Alternate Cross-Member Sloping-Member Interfaces--Figs. 5-26, 56-63

Alternate cross-member sloping-member interfaces are illustrated in Figs. 5-16. Details of the present embodiment, having a bracket **4b** with an open-ended slot **4b1**, are presented in Figs. 5-8. Other options are: a partially driven nail, or stub, **3b2** of the sloping-member combined with a drilled hole, or hollow, **4b2** in the bracket, Figs. 9-12; partially driven nails, or stubs, **3b3** disposed on either side of a solid bracket **4b3**, Figs.17-20; and a peg **4b4** and hole **4b3** combination of Figs.13–16. The peg can be accomplished by driving a nail or screw through the bracket. The corresponding hole can be easily drilled into the sloping-member. Figs. 21 and 22 show a cross-member with a middle-portion the same thickness as the end-portions. Fig. 24 and 25 show sloping-members with a continuous series of holes, Figs.22 and 23 show continuous slots. Figs. 56—59 show an end-portion projection of a cross-member which fits into a hollow of a sloping-member. Figs. 60—63 shows a hollowed area that comprises the end-portions of adjacent cross-members, which fits over a sloping member having two projections. This embodiment was tried by the inventor and was found to be inferior to the preferred embodiment. The preferred embodiment is more modular. Generally, using the preferred embodiment, one section, the area between two sloping-members can be installed and removed without much disturbance to the adjacent sections.

A commonality among alternative cross-member sloping-member interfaces is insertion, or setting, of elements of one member into, or proximate to, containing elements of the other, without fastening. The end-portions of each cross-member are generally disposed over the upper-surfaces of the sloping-members, allowing the cross-members to be held without rigid fastening, to be placed and lifted out with requiring tools, and to be placed and lifted out without disturbing adjacently placed members. These commonalities allow efficiency in placement and removal. Generally, the upper faces of the cross-members and the sloping-members do not have to be in the same plane, since panels can rest solely on the cross-members, without touching the sloping members. However, it is generally preferred that these be nearly in the same horizontal plane so the less vertical space is taken up by the grid.

Presently, the bracket with open-ended slot and raised staple, or stub, combination is preferred due to it's ease of manufacture and installation. A generic and inclusive term for an interface generally having the physical properties of the alternate connecting means described in this document is hereby defined as a projection-depression interface wherein a sloping-member having a projection and/or a depression interfaces with a projection-depression of a cross-member.

Alternate High-Side Configurations--Figs. 32-35

Several alternate high-side configurations are shown in Figs. 32-35. Each has a ledger with an upper-face **1a1** and an upstanding-face **1b1**. For the high-ledger represented in Fig. 32, the face of the adjacent structure represents an adjacent upstanding-face. Offset bracket assemblies **22**, Fig. 34 comprising a Simpson deck-tie connector extended with a plate can be used to fasten the high-ledger beneath a deck header **16.**

The different configurations of flashing **9** of each figure, contribute as a panel holding means. The panels are constrained horizontally by the upstanding face of the high-ledger and from above by the flashing. In addition, the flashing caulked acts as capable weather-guard, directing infiltration onto the panels.

Alternate Low-Side Configurations--Figs.29-31

Several alternate low-side configurations are shown in Figs. 29-31. Fig. 29 shows a low-ledger **2** held by an endboard **6**. The endboard can be fastened to a deck joist **13** with screws and to an adjacent beam **14** with a bracket. The gutter **12** in this case is fastened to an adjacent beam which is different than the case of Fig. 1, where the gutter is fastened to a low-ledger. Fastening the gutter to an adjacent beam is preferable since it takes weight off the panels and grid. In both cases the gutter is

hidden by the adjacent deck beam. In Fig. 30, the low-ledger is fastened directly to deck posts **15** and a fascia board **??** is fastened to deck posts, the bottom of the fascia-board approximately level with the bottom of the low-ledger. The fascia-board hides the gutter as well as provides support for the gutter. The configuration of Fig. 31 is sort of a hybrid of the configurations of Figs. 29 and 30. Fig. 31 has endboards as well as a fascia-board and the deck beam. This is used in cases where a deck beam is present but the required slope of the paneling would place the bottom of the gutter below the deck beam. The configuration is also used in cases where an obstacle, such as an intervening deck post, displaces the gutter away from the beam. In such a case the fascia board enhances appearance as well as provides a surface for attaching the gutter.

The low-side configuration can vary with deck configuration, however, each configuration includes a low-ledger **2**. The low-ledger may be fastened directly to deck posts or indirectly with endboards

Advantage of High-Ledger and Low-Ledger Structures

The high-side and the low-side configurations have alternates for adaptation to the deck and adjacent structure. A commonality of the alternates is a high-ledger and a low-ledger each with an upper-face and an adjacent upstanding-face. This structure allows efficiency of installation, access and removal, by placing and lifting. Another important result of these features is that the grid can be adjusted during installation, to adapt to the imperfect geometry of decks and adjacent buildings. Typically, high-ledgers and low-ledgers in combination act as a fairly uniform tray upon which a grid can be easily installed and adjusted. The upstanding, or vertical faces, of the ledgers need not be above the upper-faces of the ledgers. For example, for a 2x4 acting as a sloping-member, a square notch cut out of the bottom corners has the sloping-member resting on the upper-face of the ledger but pressing against a vertical, or upstanding, which adjacent but below the upper-face. Embodiments having joist hangers or a series of slots have upper-faces and upstanding faces as do the ledgers, but the addition of lateral faces obstructs adjustments, making installation more complicated and difficult.

Generally, it is not required for the two ledgers -- the high-ledger and the low-ledger -- that one be higher than the other. This can be done simply by adding, to the preferred embodiment, at the high-side a gutter and low-side type supporting structure. However, the disadvantages of having a level system generally include: having to supply an additional gutter, drainage and support system, accumulation of debris over level panels, accumulation of snow and ice over level panels; more difficulty in keeping an area dry for installation of a device through panels, such as a ceiling fan or a swing.

High-end, low-end, high-side, low-side and sloping-member are descriptive terms convenient for describing and comprehending the preferred embodiment of the present invention. Equivalent terms for a more general characterization of the invention are respectively, first-end, second-end, high-end, low-end, rafter-member.

Other Panel Holding Means--Fig. 1, 43-46

Panels are supported by the grid surface. The panels holding means then holding panels to the grid, restraining vertical or horizontal displacement. In general panels rest on a grid and are held, or contained, at the high-side and at the low-side. Preferably, panels are held by flashing **9** at the high-side and by panel clips **8** at the low-side. Generally, the holding means at the high-side includes the upstanding-face **1b1** of the high-ledger and the flashing. The flashing, when caulked, acts both as a holding means and a moisture barrier. The clips hold panels at the bottom.

An alternate panel holding means at the high-side is shown in Figs.43-46. Holes **17a** through the overlapping panels **10** are aligned and fitted about a projection **17b** from the upper-face of the sloping-member, the projection can be a partially driven nail. Using pre-drilled holes about 1/8-inch in diameter and finishing nails seems to work well.

In rare instances, in very windy locations, it may be necessary to fasten one or more panels. This may be done by sending a wood screw through a rafter into a high portion of the panels above. The penetration typically does not leak .In even more demanding locations a wind-strap may be applied the full width of an installation. Figs. 42 and 43 show A ½ x 1-inch strip is fastened at its ends typically at end rafters. The wind-strap typically is positioned over a row of cross-members to avoid detection from below.

Sloping-Member Support with Mid-Ledgers--Figs. 47-49

Installations with sloping-member spans greater than 10-feet usually require additional support. This may be accomplished though the use of a mid-ledger.

Fig. 47 shows a mid-ledger **19** fitted into a mid-level endboard **18**. A mid-ledger is like a low-ledger except that it has slots **19c**, Fig. 48, for the sloping-members to pass through. Fig. 49 shows a side view of a mid-ledger held by a mid-level endboard **18**, which is attached to a joist **13**. A mid-ledger is made the same way a low-ledger is made, except that it is preferable to trim ½-inch off the 5/4 board to make it 5 inches in height, which gives a lighter look. The notches **19c** are cut out generally every 24-inches to coincide with the location of the transverse sloping-members. Panels are able to rest on

the upper-edge of the mid-ledger, such that the mid-ledger in effect replaces a row of cross-members and becomes part of the grid.

Mid-Span Ledger Support with Mid-Span Hangers--Figs. 50-54

Mid-Span supports are required along the length of the ledgers (low-ledgers, mid-ledgers and high-ledgers) for otherwise unsupported lengths greater than 13 feet. If a deck post is present a wood post bracket **20**, Fig. 50, can be used. The plate **20a** for the wood post bracket is made similarly as the plates for endboards, by fastening 2 sheets of ¾-inch plywood together and cutting to shape. Brackets can be attached to the sides **20b** and bottom **20c** to complete the unit, which can be stocked for later use. Mid-span hangers **21,** Fig. 52, can be used where no posts are available. Figure 52 shows mid-span hangers utilized to increase the span for a low-ledger **2** and a mid-ledger **19**. Blocking **21c** can be made by fastening two 5/4 boards together. The blocking is then fastened to deck joists **13**, for which screws and washers **21d** can be used. A bracket **21b** is fastened to the underside of the ledger's 2x2s and the face of the ledger's 5/4 board, which extends below the 2x2. A hole is drilled through the bracket and 2x2. After the panels are set, a long screw **21a** is driven through the hole and the high corrugation of the panels above and into the blocking. The result is very leak resistant.

Other Embodiments

While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of embodiments thereof. Many other variations are possible. Various plastic or sheet metal panels can be used. The sloping members can be wood, metal, or plastic. Presently, wood members are preferred mostly due to aesthetics and ease of manufacturing. The equivalents of cross-members could be metal or plastics. One inexpensive embodiment with which the inventor has experimented is a plurality of metal j-beads, 2 to 10 feet long, with the two short legs notched out at the locations of the sloping members, with nails projecting from the sloping members to hold the j-beads in place. .For example, sloping-member with continuous slots may be manufactured from extruded aluminum. The sloping-members could have a series of projections rather than the holes that are shown in Fig. 25. If looking for strength, another embodiment the inventor has constructed has been the use of 2x4s for sloping members, 2x6s with joist hangers replacing the lower-side ledger and the upper-side ledger.

Accordingly, the scope of the invention should be limited not by the embodiments illustrated.